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Madison-Gallatin Fisheries Annual Monitoring Report

2002

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Abstract

The Madison and Gallatin watersheds provide ample fishing opportunities and an abundance of high quality aquatic resources. Managing these fisheries requires consistent monitoring and assessment of long-term trends. This document summarizes survey and inventory data collected during 2002. Trend information and current status of fisheries inhabiting major waters are provided for each survey conducted. A number of challenges exist to wild trout fisheries in the area, such as whirling disease, increased angling pressure, and drought. Nonetheless, most fisheries in the area are healthy and likely to persist with continued protection of habitat and water quality and quantity.

Acknowledgements

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Introduction

The rivers, lakes, streams and reservoirs of the Madison and Gallatin watersheds support abundant high quality aquatic resources. Of the 699, 747 angler-days exerted in Fish, Wildlife, and Parks (FWP) administrative Region 3, approximately 47% occurred in these watersheds (MacFarland and Meredith 2002). Diverse fisheries in the Madison and Gallatin provide substantial recreational and economic value to the state and local communities. World-renowned trout rivers, alpine lakes, three reservoirs, and numerous urban ponds each provide a different angling experience and management challenge.

Montana Fish, Wildlife, and Parks' Fisheries Division is funded through hunting and fishing license sales and through the Federal Aid in Sport Fish Restoration Act (16 U.S.C 777-777k). Broad objectives for the Fisheries Division are established in a Six-Year Operations Plan (FWP 2000a). Objectives modified from the plan are:

1. Survey and Inventory: Survey and monitor the characteristics, status, and trends of fish populations, habitats, and angler use and harvest in selected streams and lakes,
2. Technical Guidance and Information: Review projects, public and private, that have the potential to affect fisheries resources and provide technical advice to sustain and enhance fisheries resources,
3. Fish Population Management: Implement fish stocking programs in habitats that can't sustain fisheries naturally, to maintain fish populations and angler opportunities, and
4. Aquatic Education: Enhance the awareness, understanding, and support of aquatic resources by the general public to ensure that quality aquatic resources persist that encourage recruitment of young anglers and advocates.

Monitoring is a critical component to managing quality fisheries and aquatic habitats. This report summarizes survey and monitoring activities within the Madison – Gallatin District, project F-113 R2 and F-113 R3 for calendar year 2002. Data reported herein are continuations of historic monitoring and may have been recently reported by Byorth (2000a, 2000b) and Byorth and Weiss (2001, 2002). This report provides only basic trend information as an index of the status of certain fisheries. Long-term monitoring provides the context for interpreting annual data. Further analysis is necessary to draw conclusions beyond basic trends.

Description of Study Areas

Gallatin River

The Gallatin River is the easternmost of three major Missouri River headwaters draining approximately 1800 miles² of southwestern Montana (Figure 1) (Shields et al. 1999). Wild trout fishing is the prominent attraction to the East and West Gallatin rivers, and their tributaries. These streams provided an estimated 102, 836 angler-days in 2002, a decrease from 107, 315 angler days in 1997 and 121,146 in 1999 (McFarland and Meredith 1999, 2000, 2002).

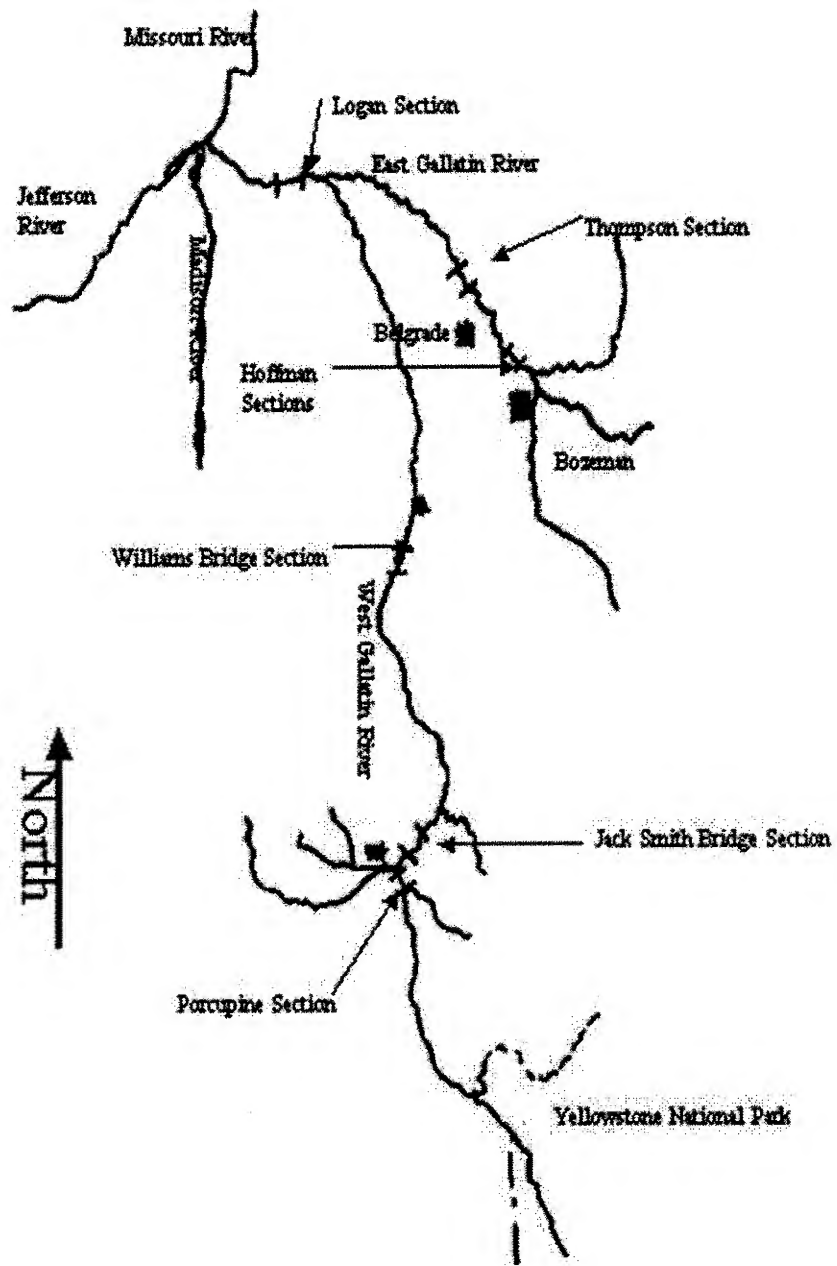


Figure 1. Map of the Gallatin Drainage, showing population monitoring study sections.

The West Gallatin River flows north through the high-altitude, narrow Gallatin Canyon, which divides the Madison and Gallatin mountain ranges. The canyon governs typically cool mid-summer water temperatures and harsh winter conditions. Trout grow slowly in the cool water temperatures: an average rainbow trout (*Oncorhynchus mykiss*) in the upper West Gallatin River will grow only to 12 inches after 4 to 5 years (MFWP Files). Severe winter conditions regulate trout abundance. In dry years, the lower West Gallatin River becomes severely dewatered by irrigation diversions (Vincent 1978). The lower 35 river miles of the West Gallatin River is more heavily influenced by irrigation diversions and channel instability. Urban and suburban development has increased attempts to stabilize the river by channelization and riprapping.

We monitor Fall trout populations in three survey sections in the upper West Gallatin River: the Porcupine Section (2.3 miles: from Porcupine Creek to the West Fork of the West Gallatin River), Jack Smith Section (2.2 miles: Jack Smith Bridge, Highway 191 North of Big Sky) and the Williams Bridge Section (2.84 miles: Williams Bridge to 1 mile South of Gallatin Gateway) (Figure 1). The Jack Smith and Porcupine Sections are sampled in even-numbered years (e.g. 2000, 2002), while the Williams Bridge Section is sampled in odd numbered years (e.g. 2001, 2003). Each of these sections has been electrofished intermittently since the 1980's. Detailed maps of each section are in Appendix A.

The headwaters of the East Gallatin River drain the Gallatin, Bangtail, and Bridger ranges, joining near Bozeman (Figure 1). The 40 mile course of the East Gallatin River winds through developed urban, suburban, and agricultural areas before its confluence with the West Gallatin River. In the past, fish populations were heavily influenced by effluent from the Bozeman Municipal Sewage Treatment Plant. The primary treatment plant was replaced by a secondary treatment facility in 1971, improving water quality and increasing wild trout abundance (Vincent 1978, Vincent 1979, Vincent and Rehwinkle 1981).

Two contiguous study sections have been sampled annually during fall to monitor trout population trends in the East Gallatin River. The Upper Hoffman section extends 0.88 miles from Springhill Road Bridge to approximately 100 yards above the sewage outfall. The Lower Hoffman Section begins at the sewage outfall and extends 1.05 miles downstream.

The Thompson Section was reestablished in Spring of 2001. The section lies between Penwell Bridge and the mouth of Trout Creek (1.6 miles), approximately 3 miles northwest of Belgrade, MT. In this reach, the East Gallatin River increases in flow due to substantial groundwater accretions. Historically, this reach was severely impacted by channelization and agricultural practices. The last time fish populations were sampled in the Thompson Section was in 1984. We sampled this section to monitor trout populations and increasing risks of whirling disease in the basin.

The East and West Gallatin rivers join approximately 12 river miles upstream of the headwaters of the Missouri River. Combined influences of irrigation withdrawals, urban development, and sedimentation appear to restrict trout populations in the mainstem Gallatin River. The Logan Section is electrofished

during spring to monitor trout populations in the mainstem. The section is 4.3 miles long extending from Nixon Bridge to near the town of Logan, Montana (Figure 1).

Madison River

The Madison River forms in Yellowstone National Park, flowing into Montana near Hebgen Reservoir (Figure 2). The Madison's legendary trout fishery remains one of the most popular in the United States (Sample 1998, Ross 1999.) The Madison River is the home of "wild trout management", where management emphasis shifted from stocking trout to population monitoring, harvest regulation, and habitat protection (Vincent 1987, Vincent et al. 1990).

Madison River trout populations were monitored by electrofishing three study sections in 2002 (Figure 2). Detailed maps of each section are in Appendix A. The Pine Butte section lies approximately 12.0 miles below Quake Lake, extending from Pine Butte Creek to Lyons Bridge (3.0 miles). The Madison River through this reach has fairly uniform gradient, with a network of side channels that influence spawning and recruitment. The West Fork Madison River enters the Pine Butte Section approximately 0.6 miles above Lyons Bridge. Fishing regulations on this reach have been catch-and-release only for trout since 1978 and no fishing from boats has been allowed since 1974. Since 1995, the fishing season has been open from the third Saturday in May through the end of February to protect spawning rainbow trout. Population estimates have been conducted on the Pine Butte Section since 1977.

The Madison River changes character considerably in the Varney Section, approximately 40 miles downstream from Quake Lake. This section extends from Varney Bridge to Eight Mile Ford Fishing Access Site, a length of 4.0 miles. Brown trout predominate in the complex and heterogeneous habitats that a braided channel provides. Habitat in the Varney section is highly influenced by ice gorging (Vincent 1990). Annual fall population surveys have been conducted in the Varney Section since 1967. Fishing regulations allow harvest of 5 brown trout (*Salmo trutta*), only one over 18 inches long, catch-and-release only for rainbow trout, in effect since 1992.

The Madison River changes significantly below Ennis Dam. After flowing 8 river miles through Beartrap Canyon, the Madison flows through a low gradient, broad and shallow channel with extensive weed beds and fine sediments. Mid-summer water temperatures climb to near lethal levels in this reach, causing fish kills in dry, and hot years (Vincent et al. 1981). We monitor trout populations in the 4.0-mile Norris section, extending from the mouth of Warm Springs Creek to the mouth of Cherry Creek. This reach is open to fishing year-round with a combined trout limit of 5 fish, only 1 over 18 inches long. Population estimates have been conducted in spring in the Norris Section annually since 1970.

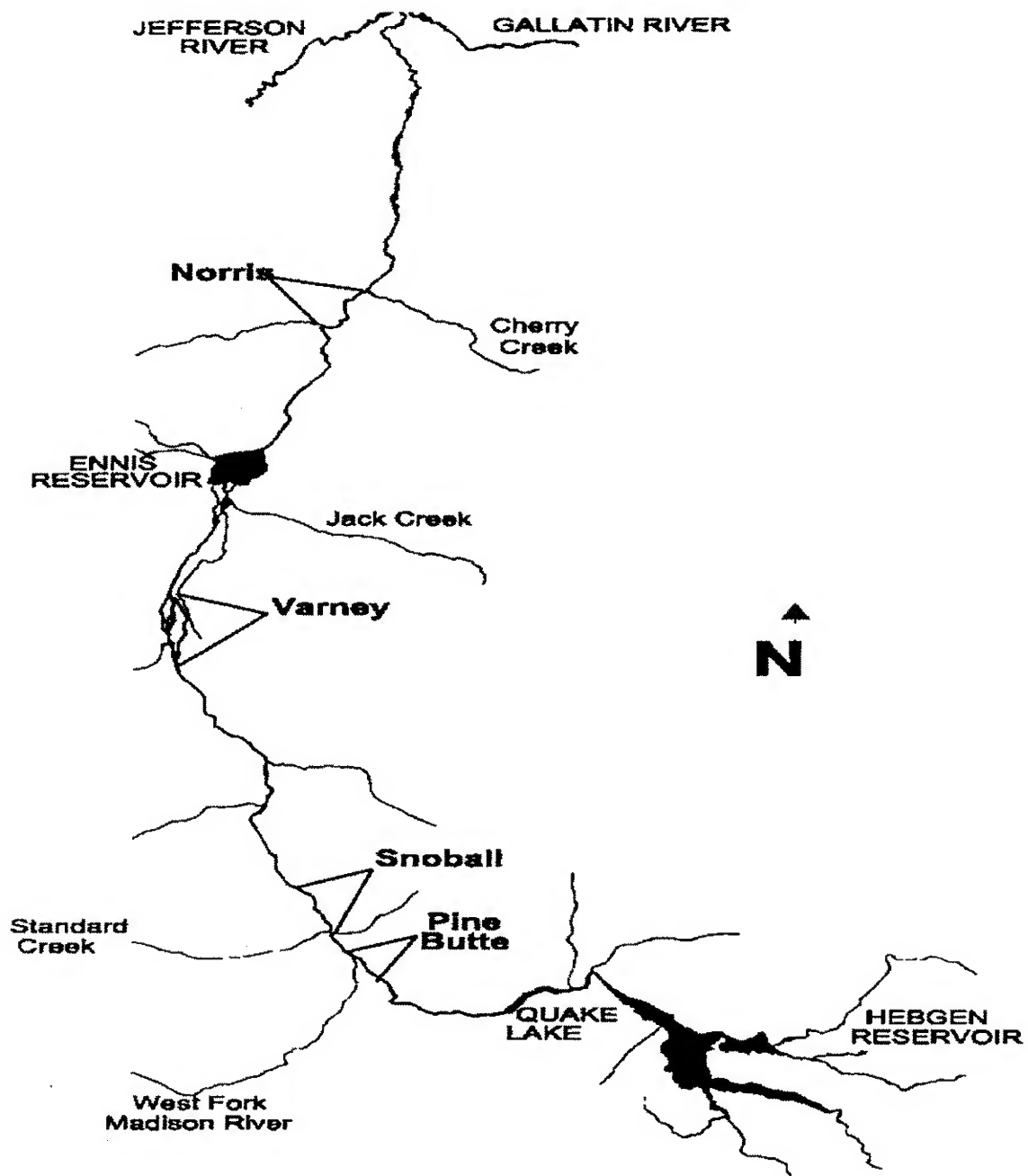


Figure 2. Map of Madison River drainage with population survey study sections.

Hebgen Lake

Hebgen Lake is a storage impoundment on the Madison River, formed by Hebgen Dam in 1915. The dam is owned and operated by PPL Montana under FERC License 2188 to regulate flows to the hydroelectric plant at Madison Dam near Ennis. At full pool elevation of 6534 feet above mean sea level (amsl), the reservoir's surface area is 12668 acres. The primary fishery management goal at Hebgen Lake is to establish a self-sustaining rainbow trout population. The reservoir fishery is supported by wild, self-sustaining brown trout and rainbow trout, but is supplemented with annual plants of 100,000 eagle lake rainbow trout fry, a wild strain. Mountain whitefish (Prosopium williamsoni), native to the Madison Drainage, also complement the fishery. Utah chubs (Gila atraria), introduced circa 1935, occupy a large proportion of fish biomass in Hebgen Lake (Leik 1978).

Cliff and Wade Lakes

Cliff Lake is a natural lake at an elevation of 6313 amsl covering approximately 620 surface acres. Naturally reproducing rainbow trout have historically sustained this fishery, although it was occasionally supplemented with hatchery plants. Cliff Lake's fishery has struggled in the last 40 years. A 1961 graduate project found the lake's rainbow trout population to be heavily parasitized (Fox 1961). This, accompanied by disease and overpopulation, was suspected as a reason for the fishery's decline.

Wade Lake is a 240 acre natural lake, the last in the same chain as Cliff Lake. It lies at an elevation of 6217 amsl. Wade Lake is sampled periodically to ensure trout populations are stable, but no sampling was conducted in Wade Lake in 2002.

Hyalite Reservoir

Hyalite Reservoir is an irrigation storage impoundment on Hyalite (Middle) Creek, filled in 1951 with the completion of the Hyalite (Middle) Creek Dam. In 1993, dam reconstruction raised full pool elevation 8.2 vertical feet to 6715 amsl with surface area of approximately 260 acres. The increase in pool elevation inundated critical spawning habitats, apparently impacting Yellowstone cutthroat trout (Oncorhynchus clarki bouveri) and Arctic grayling (Thymallus arcticus) populations (Byorth and Weiss 2001). Summer and fall irrigation in the Gallatin Valley and municipal diversions significantly draw pool elevations down each year. While Hyalite Reservoir sustains wild, self-sustaining populations of Yellowstone cutthroat trout (YCT), Arctic grayling, and brook trout (Salvelinus fontinalis), approximately 30,000 YCT fry are planted annually.

Recent management efforts focused on maintaining satisfactory angler catch rates of YCT by supplementing the naturally reproducing population with McBride strain hatchery YCT. In addition, we are monitoring success of mitigation at protecting the grayling population in conjunction with the Gallatin National Forest. In 2002, a series of log jams were created by felling conifers into the stream channel to enhance scour and deposition of spawning gravels, to provide overhead cover for spawners, and to enhance rearing habitat.

Miscellaneous Surveys

In June 2002, we surveyed Deer and Moon lakes in the Deer Creek drainage (T6SR4E Sec. 7), approximately 28 miles southeast of Bozeman, MT. Deer Lake lies at an elevation of 9120 feet amsl. A wild, self-sustaining population of Arctic grayling inhabits Deer Lake. Moon Lake is less than a mile south of Deer Lake at 8950 ft amsl. Moon Lake supports a self-sustaining population of rainbow-cutthroat trout hybrids. We characterized the spawning population to document natural reproduction by electrofishing spawning streams at each lake.

Methods

Electrofishing is used to conduct Mark-Recapture experiments to estimate trout populations. A drift boat-mounted, mobile anode system is used to capture trout on large rivers such as the Madison, Gallatin, and East Gallatin rivers. The drift boat system is equipped with 4,500 Watt generator and Coffelt Mark XXII-M rectifying Unit. During electrofishing runs trout are netted, held in a live well, anesthetized in an MS-222 bath, measured to 0.1 inches in total length, weighed to 0.01 lbs, marked with a fin clip, and released after recovering. Multiple marking runs are followed by recapture runs after 10 to 14 days. The number of electrofishing passes is determined by the sample sizes required to construct statistically valid population estimates (generally more than 10% of the population). The ratio of marked to unmarked fish in the recovery sample is used to estimate abundance according to FWP's computerized Mark-Recapture Log-likelihood model. On smaller streams, we use a backpack-mounted electroshocker to capture trout and generally use similar fish handling methods and calculate depletion estimates. Scale samples are collected for age determination and to determine age class abundance. Detailed maps of study sections are in Appendix A.

We use gill nets to sample Hyalite Reservoir, Hebgen Lake, and Cliff Lake. We set experimental gill nets 125 feet long by 6 feet deep with a bar mesh ranging from 1 to 3 inches. At Hebgen Reservoir, annual sampling occurs during the last week of May or the first week of June. A combination of 24 to 27 bottom and surface nets were set over a three-night period. Nets are set at consistent locations each year, although low reservoir levels dictated the omission of certain sets in some years (Appendix A). Gill nets were set at Cliff Lakes in October 2002. In addition to the traditional four surface nets, we changed the location of one sinking net and added another in Cliff Lake. (Appendix A). We set 3 floating and 1 sinking gill nets in Hyalite Reservoir in October 2002 (Appendix A).

On each lake or reservoir, gill nets are set during late afternoon and retrieved the following morning. Fish found alive are processed and released. All fish caught in nets are identified to species, measured to nearest 0.1 inch in total length, weighed to nearest 0.01 lb., and examined for marks, hook scars, and sexual condition. Scale samples are taken from trout for age analysis. On Hebgen Reservoir, rainbow trout were examined for external hatchery characteristics and we extracted vertebrae from deceased specimens to examine for tetracycline marks. A microscope and a blacklight were used to examine vertebrae for tetracycline marks.

Hyalite Reservoir salmonids are monitored annually by spawning surveys. Yellowstone cutthroat trout and Arctic grayling both spawn in the West and East Forks of Hyalite Creek. Spawner counts are conducted May – July annually, from reservoir pool elevation to Window Rock Bridge on the West Fork. Surveyors walk upstream, counting adult fish of both species, generally 2 days per week for the duration of spawning (generally mid-May to mid-July).

Results

West Gallatin River

Trout populations are stable in reaches of the West Gallatin where monitoring is conducted. In the Gallatin Canyon (Porcupine and Jack Smith sections) rainbow trout predominate and brown trout are present in low numbers. Brown trout abundance in the Porcupine Section was estimated to be 66 per mile in 1998, 118 per mile in 2000, and 110 per mile in 2002. Apparently, brown trout recruitment is very limited in the canyon. Rainbow trout populations in the canyon were the highest on record for fish 8.0 inches and longer. This is a continuation of a long-term trend in both Porcupine and Jack Smith sections since an apparent decline in the mid 1990's in both sections.

In the Porcupine Section, numbers of rainbow trout 8 inches and longer increased above levels documented in 1998 and 2000 (Table 1). However, the oldest rainbow trout in the largest size class (>13.0 inches) declined from previously recorded highs to near long-term average (Table 1). However, age 4 and 5+ rainbow trout remain at healthy levels relative to 1996 levels (Table 2). Age 2 and 3 rainbow trout are stable at strong levels and are likely to maintain numbers of larger trout in the next few years. Ample recruitment is apparent in Age 1 and 2 rainbow trout, likely due to low intensity spring runoff in the last few years. Table 3 demonstrates the slow growth rates of rainbow trout in the Gallatin Canyon, reaching only an average of 9.0 inches as age 3, the likely age of sexual maturity.

Table 1. Rainbow trout population summary for trout longer than 8.0 inches (generally Age 3 and older) in the Porcupine Section of the West Gallatin River, Fall 1984 – 2002. Values are number per river mile by length category.

Year	Number > 8 inches	Number > 10 inches	Number > 13 inches
1984	915	329	29
1987	1250	412	25
1995	819	386	100
1996	558	333	87
1998	1355	702	162
2000	1221	629	143
2002	1514	770	104

Table 2. Rainbow trout population estimates by age class in the Porcupine section of the West Gallatin River, Fall 1996, 1998, 2000. Values for 2002 are based on previously documented length-at-age estimates and should be considered preliminary. Values are number per river mile. Standard deviations (SD) are provided for total population estimates for finalized estimates.

Year	Estimated Number By Age Class (number per mile)					Total (SD)
	Age 1	Age 2	Age 3	Age 4	Age 5+	
1996	570	358	269	111	198	1510 (47)
1998	384	383	418	406	566	2157 (245)
2000	278	447	515	303	357	1900 (210)
2002	408	1031	744	469	301	2953

Table 3. Mean length-at-age of rainbow trout in the Porcupine Section of the West Gallatin River, Fall 1996, 1998, and 2000.

Year	Mean Length by Age Class (inches)				
	Age 1	Age 2	Age 3	Age 4	Age 5
1996	4.7	6.9	8.7	10.5	12.8
1998	5.4	7.3	8.9	10.1	11.5
2000	5.2	7.0	9.2	10.5	12.7
3 year Mean	5.1	7.1	8.9	10.4	12.3

Rainbow trout populations in the Jack Smith section are similar to the Porcupine section, displaying a peak in density in the late 1980's with a decline in the mid 1990's and a more recent increase. While rainbow trout abundance in the Jack Smith Bridge section increased more recently than in the Porcupine Section, rainbow trout abundances remain at high levels (Table 4). Population estimates in 2000 and 2002 are substantial. Byorth and Weiss (2002) questioned whether high abundances in 2000 were an artifact of conditions during sampling. However, the 2002 estimates confirm the validity of the 2000 estimates. While estimated abundances decreased across size classes relative to 2000, the rainbow trout population in the Jack Smith section remains strong. Analysis of age class strength indicates strong survival of the 1997 (Age 3 in 2000, Age 5 in 2002) and the 1998 year class (age 2 in 2000, age 4 in 2002) (Table 5).

Table 4. Estimated population of rainbow trout in the Jack Smith section of the Gallatin River obtained during the late summer or early fall of 1981-1984, 1989, 1995-1996, 1998, 2000, and 2002. Estimates are presented as number per river mile.

Year	Number > 8 inches	Number > 10 inches	Number > 13 inches
1981	2819	1169	167
1982	2308	910	99
1983	2596	1217	108
1984	2490	1149	123
1989	3449	1413	131
1995	1460	896	181
1996	1505	936	237
1998	1464	749	167
2000	4946	2381	402
2002	3453	1945	286

Table 5. Estimated rainbow trout abundance in the Jack Smith Section of the West Gallatin River by age class, fall 1981 – 2000. Abundance estimates are in number per river mile. The estimate for 2002 is based on previously documented length-at-age ratios and should be considered preliminary. The others are based on actual scale samples and standard deviations (SD) are provided for total population estimates.

Year	Age 2	Age 3	Age 4	Age 5+	Total (SD)
1981	2034	973	353	182	3542 (574)
1982	1951	1017	279	80	3327 (211)
1983	1784	1300	431	123	3640 (217)
1984	936	1324	614	387	3262 (198)
1989	2231	1453	763	270	4718 (321)
1995	437	380	350	855	2022 (229)
1996	1086	507	327	827	3257 (398)
1998	676	700	473	211	2882 (345)
2000	2606	2178	630	687	7450 (804)
2002	1709	1508	1086	859	5162

East Gallatin River

Trout populations in the East Gallatin River have been relatively stable. In the Upper Hoffman Section, numbers of rainbow trout increased slightly in all size classes from levels documented in 2001 (Table 6). Brown trout abundance was very similar to levels in 2001. In the Lower Hoffman Section, both rainbow and brown trout abundance decreased in each size class. The Upper and Lower Hoffman Sections

are contiguous, so it is odd that trout abundances documented in 2002 were inconsistent between sections. Generally, both sections follow the same trend. Without more complete analysis of age class strength, it is difficult to assess the reasons for these mixed results. Length-at-age information is summarized in Table 7.

The presence of Myxobolus cerebralis, the parasite that causes whirling disease in salmonids, has been documented in the East Gallatin River and the intensity of infection in rainbow trout is increasing (D. Vincent, Pers. Comm.). Whirling disease is likely to impact rainbow trout populations in the near future and infection rates may be higher below the outfall of the sewage treatment plant. Ongoing investigations will clarify the impacts of whirling disease in the East Gallatin River.

Table 6. Rainbow and brown trout population summary (age 1+) for the upper and lower Hoffman sections of the East Gallatin River, 1994 - 2002. Population estimates per mile are listed by length group.

Upper Hoffman Section (1.2 miles)						
Year (Fall)	rainbow trout per mile			Brown trout per mile		
	≥ 6.0 inches	≥ 10.0 inches	≥ 13.0 inches	≥ 6.0 inches	≥ 10.0 inches	≥ 13.0 inches
1994	2550	600	110	847	645	271
1995	2157	450	141	1103	669	453
1996	2397	628	68	384	310	229
1997	1701	697	125	290	155	99
1998	3108	668	152	522	266	137
1999	4877	1712	213	663	427	208
2000	3408	1083	188	1053	724	358
2001	1649	648	80	748	458	262
2002	2014	830	143	693	522	269
Lower Hoffman Section (0.88 miles)						
Year (Fall)	≥ 6.0 inches	≥ 10.0 inches	≥ 13.0 inches	≥ 6.0 inches	≥ 10.0 inches	≥ 13.0 inches
1994	2089	748	219	556	397	226
1995	3498	1108	320	501	363	225
1996	2557	1234	277	646	550	464
1997	1915	982	405	359	316	149
1998	3376	1237	329	647	355	283
1999	4801	2288	653	757	539	198
2000	4633	3164	647	765	408	205
2001	2326	1700	739	526	319	138
2002	1795	1309	584	303	260	131

Table 7. Length-at-age (inches) estimates for rainbow and brown trout in the Hoffman sections of the East Gallatin River based on scale samples 1985 – 1987.

Species	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6
Rainbow Trout	7.3	9.3	10.7	11.9	13.2	13.7
Brown Trout	8.1	10.5	12.6	14.0	15.0	16.0

The Thompson section of the East Gallatin River was electrofished in spring of 2001 and 2002 to characterize trout populations and assess the potential effects of whirling disease on rainbow trout. Rainbow trout predominate in the Thompson Section, although both rainbow and brown trout are significantly less abundant than in the Hoffman sections approximately 7 air miles upstream. Both rainbow and brown trout abundances reflect a lack of juvenile trout, comprising less than 15% of the populations (Table 8). Recruitment limitation of rainbow trout could be explained by the presence of whirling disease. However, brown trout are resistant to whirling disease, so the factor limiting their reproductive success may be water quality related. Rainbow trout recruitment may be limited by the same factor. In either case, both trout populations decreased between 2001 and 2002, almost certainly due to drought related conditions.

Table 8. Rainbow and brown trout population estimates (number per mile) in the Thompson Section (1.6 miles below Penwell Bridge) of the East Gallatin River, Montana, Spring 2001 and 2002.

	Brown Trout			Rainbow Trout		
Year	>5.0 inches	>10.0 inches	>13.0 inches	>5.0 inches	>10.0 inches	>13.0 inches
2001	449	437	331	928	879	626
2002	450	390	243	758	654	402

Gallatin River

The Gallatin River below the confluence of its forks suffers a variety of cumulative impacts including sedimentation, warm water temperatures, dewatering, and presence of *M. cerebralis*, the causative agent of whirling disease. Trout population estimates are relatively stable at low levels relative to both forks of the Gallatin River. Estimated rainbow and brown trout populations decreased from 2001, which may be attributable to persistent drought conditions (Table 9). Larger fish dominate both rainbow

and brown trout populations. The absence of juvenile rainbow or brown trout (less than 10 inches long) indicates recruitment limitation. This may be symptomatic of whirling disease, although brown trout are not subject to the disease.

Table 9. Rainbow and brown trout population estimates (number per mile) in the Logan Section (4.3 miles below Nixon Bridge) of the Gallatin River, Montana, Spring 1999-2002.

	Brown Trout			Rainbow Trout		
Year	>6.0 inches	>10.0 inches	>13.0 inches	>6.0 inches	>10.0 inches	>13.0 inches
1999	473	390	208	353	270	107
2000	350	307	128	321	281	103
2001	304	274	184	487	454	344
2002	302	267	143	392	370	240

Madison River

Rainbow and brown trout populations in the Madison River above Ennis Reservoir have been affected by a variety of influences over the years (Byorth 2000a). Since 1991, whirling disease has been the primary factor limiting rainbow trout populations in the upper Madison (Vincent 1996). The rainbow trout population in the Pine Butte section declined since it peaked in 1999 and 2000. While the 1998 year class of rainbow trout survived well into larger size classes, the 1999 and 2000 year classes were substantial, but experienced limited survival to maturity.

Drought-related conditions are the most likely factors affecting survival and recruitment of juvenile trout. Lower stream flows have been implicated in increasing susceptibility of emergent rainbow trout fry to whirling disease in the upper Madison River (Dick Vincent, personal communication). Lower stream flows during late fall and winter apparently diminish winter habitat quality for juvenile trout and may amplify effects of whirling disease on juvenile rainbow trout. Flow related limiting factors are further evident in brown trout population estimates (Table 10). Strong brown trout year classes from 1995 to 1998 occurred during years of ample moisture, when overwinter survival of yearling trout increased as fall drafting of Hebgen Reservoir increased late fall and winter flows (Table 11). Lower fall and winter flows since 2001 appear to have impacted brown and rainbow trout populations, affecting recruitment of

juveniles and survival of adult brown trout. However, brown trout abundance is still within long-term ranges.

Table 10. Rainbow and brown trout population estimates in (number per mile) the Pine Butte Section (3.0 Miles above Lyons Bridge) of the Madison River, Montana, Fall 1994-2002. Standard deviations (SD) are listed for finalized estimates.

Year	Rainbow Trout		
	Age 1 Per Mile	Age 2 and older Per Mile	Total Age 1 and older Per Mile (SD)
1994	94	236	330 (20.5)
1995	510	175	685 (65.8)
1996	735	447	1182 (88.9)
1997	454	267	809 (73.3)
1998	847	305	1152 (85.9)
1999	2729	656	3385 (465.6)
2000*	2100	1659	3759
2001*	1794	702	2496
2002*	661	420	1081

Year	Brown Trout		
	Age 1 Per Mile	Age 2 and older Per Mile	Total Age 1 and older Per Mile (SD)
1994	282	919	1201 (157.7)
1995	620	509	1129 (70.7)
1996	1158	446	1604 (84.2)
1997	831	929	1760 (154)
1998	1018	794	1812 (103.4)
1999	1419	1373	2792 (497.7)
2000 *	962	1171	2133
2001*	728	1024	1752
2002*	585	534	1119

*2001 Preliminary, based on historic age data, subject to change with actual scale data.

Table 11. Mean Monthly Stream flows for the Madison River at the Kirby Gage, 1995 –2002. Values (in bold) for October 2001 through December 2002 are estimated from USGS provisional data (USGS Web Site: <http://waterdata.usgs.gov/mt/nwis/current>)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
1995	802	810	1,097	1,527	2,019	2,581	1,253	1,295	1,566	1,805	1,802	1,102
1996	971	931	940	1,041	2,749	3,552	1,544	1,259	1,567	2,136	2,026	1,323
1997	1,385	1,398	1,386	1,409	2,864	3,862	1,757	1,671	1,529	2,019	2,080	1,409
1998	1,338	1,313	1,224	1,220	1,558	2,803	2,067	1,261	1,184	1,178	1,247	1,379
1999	1,449	1,521	1,611	1,491	1,895	2,955	1,561	1,205	1,152	1,220	1,262	1,252
2000	1,243	1,242	1,290	1,298	1,734	1,704	1,161	1,063	1,149	1,162	1,136	1,146
2001	1,140	1,124	923	708	882	756	1,033	956	968	960	960	940
2002	920	870	825	825	840	1200	1500	1500	980	950	900	900
Mean of monthly streamflows	1,068	1,051	1,059	1,028	1,394	1,895	1,325	1,150	1,201	1,674	1,676	1,272

In the Varney section, brown trout are the predominant species contributing to the trout fishery. After fall populations of age 1 and older brown trout peaked in 1998, they remained strong through 2000 at above average levels (Table 12). In 2001, abundance of brown trout decreased across age groups, in spite of apparently good recruitment of the 1999 year class. Stronger juvenile brown trout recruitment boosted the population in 2002, although continued flow limitations may have impacted over-winter survival into 2003.

Rainbow trout significantly decreased in abundance in the Varney section in the mid-1990's, apparently as a result of whirling disease (Byorth 2000a). In the Varney section, estimated fall rainbow trout abundance increased with good recruitment from the 1998 and 1999 year classes, similar to the Pine Butte Section. A downward trend in rainbow trout abundance began in 2001 with diminished recruitment from the 2000 and 2001 year classes. However, the 2000 year class recruited well to the adult population, and maintained the rainbow trout population in the Varney Section near average numbers in 2002.

Table 12. Rainbow and brown trout population estimates (number per mile) in the Varney Section (Varney Bridge to Eight-mile Ford, 4.0 miles) of the Madison River, Montana, Fall 1994-2002. Standard deviations (SD) are listed for finalized estimates.

Year	Rainbow Trout		Total Age 1 and older Per Mile (SD)
	Age 1 Per Mile	Age 2 and older Per Mile	
1994	33	166	199 (27.6)
1995	351	132	483 (70.4)
1996	145	304	449 (54.9)
1997	106	113	282 (28.3)
1998	192	139	331 (36.2)
1999	740	236	976 (190.4)
2000*	1366	409	1775
2001*	714	281	995
2002*	634	535	1169

Year	Brown Trout		Total Age 1 and older Per Mile (SD)
	Age 1 Per Mile	Age 2 and older Per Mile	
1994	1278	631	1909 (75.1)
1995	770	704	1474 (76.3)
1996	1558	515	2073 (84.4)
1997	1122	949	2071 (123.5)
1998	2180	1061	3241 (132.8)
1999	1674	1244	2918 (194.0)
2000*	1706	1076	2782
2001*	1133	850	1983
2002*	1237	1103	2340

*2000-02 Preliminary, based on historic age data, subject to change with actual scale data.

Trout populations of the Madison River below Ennis Reservoir are subject to different environmental factors than above Madison Dam. Ennis Reservoir acts as a thermal sink, increasing mid-summer water temperatures (Vincent et al. 1981). While warm temperatures apparently suppress whirling

disease, temperatures can approach lethal levels and affect trout survival. By 2001, rainbow and brown trout abundance in the Norris Section had nearly recovered from low levels in the mid-1990's (Table 13). However, persistent drought conditions appear to have affected survival of Age 3 and older rainbow and brown trout in 2002. Numbers of Age 2 brown trout in Spring 2002 are low, reflecting poor recruitment in 2000 or sampling error.

Table 13. Rainbow and brown trout population estimates (number per mile) in the Norris Section (Warm Springs Creek to Cherry Creek, 4.0 miles) of the Madison River, Montana, Spring 1994-2002. Standard deviations (SD) are listed for finalized estimates.

Year	Rainbow Trout		Total Age 2 and older Per Mile
	Age 2 Per Mile	Age 3 and older Per Mile	
1995	273	531	804 (55.7)
1996	184	535	719 (62.5)
1997	552	220	772 (38.7)
1998	555	736	1291 (104.5)
1999	820	772	1592 (266.9)
2000	330	937	1267 (76.6)
2001*	643	1422	2065
2002*	868	758	1626

Year	Brown Trout		Total Age 2 and older Per Mile (SD)
	Age 2 Per Mile	Age 3 and older Per Mile	
1995	435	706	1141 (254.2)
1996	696	510	1206 (64.0)
1997	294	613	882 (63.0)
1998	601	507	1108 (66.1)
1999	980	1017	1997 (356.0)
2000	968	686	1654 (93.1)
2001 *	1085	1154	2239
2002*	626	989	1615

*2001-2002 Preliminary, based on historic age data, subject to change with actual scale data.

Hebgen Reservoir

Annual spring gill net series are used to gather trend information as an index of relative abundance of game and non-game species. While wild reproduction predominates for all species, approximately 100,000 Eagle Lake strain rainbow trout are stocked annually. In 2002, catch of rainbow trout in floating nets (the best index of rainbow trout abundance) rebounded to above average levels (Table 14). Long term average catch per net between 1973 and 2001 was 5.4 (SD 3.43) rainbow trout per net in spring floating nets. Prior to 1986, the onset of stocking wild strains of rainbow trout, net catches averaged 2.42 (SD 1.02) rainbow per floating net. Since 1986, spring catch rates of rainbow trout have averaged 6.76 (SD 3.28) (Byorth and Weiss 2002). While decreased natural reproduction due to drought conditions or poor planting success could explain lower catches in 2001, the low catch may have been due to sampling error.

We are still assessing the contribution of stocked rainbow trout to the Hebgen Reservoir fishery and rainbow trout population. We are using a combination of observation of dorsal fin erosion,

tetracycline (tet) marks, and adipose fin clips to assess whether rainbow trout captured in gill nets are from hatchery or wild origin. Byorth and Weiss (2002) summarized inconsistencies in results of different point-of-origin methods, concluding that hatchery comprised less than 25% of the rainbow trout population. In 2002, 17 of 51 rainbow trout captured in gill nets expressed a tet-mark. These rainbow trout ranged in length from 11.1 inches to 15.8 inches, probably 2 and 3 year old trout. Of rainbow trout positive for a tet-mark, 70% also exhibited dorsal fin erosion. In combination, fin erosion and tet-marks indicate the highest proportion of hatchery rainbow trout in recent years (Table 15). We will continue to research hatchery contribution to the rainbow trout population.

Catches of brown trout in gill nets in Spring 2002 decreased slightly from 2001. We caught 7.1 brown trout per sinking nets (the best index for brown trout abundance) which is below the long term average of 10.94 (SD 3.44) since 1971 (Table 14). However, the gill net catch is consistent with catches since 1995. Mountain whitefish catch rates have been relatively stable since 1994, although the catch per sinking net fell in 2002 to the lowest levels in the period (Table 14). Utah chub catches have fluctuated widely since 1994, apparently rebounding significantly in sinking nets, but decreasing from high levels recorded in 1999 in floating nets.

Table 14. Summary of rainbow trout (RB), brown trout (LL), mountain whitefish (MWF), and Utah chub (UC) catch-per-net in Spring gill net series on Hebgen Reservoir, 1995 to 2002.

YEAR	NO. OF NETS	Floating Nets		MWF/NET	UC/NET
		RB/NET	LL/NET		
1995	12	15.3	8.4	1.1	18.9
1996	14	5.9	4.3	0.7	54.6
1997	14	5.6	3.9	0.1	89.2
1998	14	9.4	2.6	1.1	41.1
1999	13	7.2	13.3	1.5	143.2
2000	14	6.0	3.7	0.2	96.0
2001	14	2.5	2.4	0.29	62.5
2002	14	7.0	3.2	0.9	53.3
YEAR	NO. OF NETS	Sinking Nets		MWF/NET	UC/NET
		RB/NET	LL/NET		
1995	12	0.8	7.1	18.5	13.4
1996	13	0.9	7.5	16.8	55.5
1997	11	0.8	8.5	16.3	24.5
1998	10	1.1	6.5	12.0	60.2
1999	11	0.8	11.7	19.4	26.6
2000	11	0.7	9.5	11.7	33.3
2001	11	0.5	11.1	18.1	69.2
2002	11	0.6	7.1	11.4	115.5

Table 15. Summary of contribution of wild and hatchery-reared rainbow trout to gill net catches in Hebgen Reservoir, 1996 – 2001. Asterisks indicate incomplete data.

Year	% Catch Rainbow Trout With Dorsal Fin Erosion	% of Sample Tet-Mark Positive
1996	5.2 *	2.9
1997	13.8	2.7
1998	22.4	no data
1999	3.9 *	2.9
2000	16.0	6.3
2001	22.5	0.0
2002	17.0	33.0

Cliff and Wade Lakes

Over the years, monitoring of fish populations in Cliff and Wade lakes has been limited to gill netting or night electrofishing. In 2002, we did not sample Wade Lake and only gill netted at Cliff Lake. Gill netting catches have varied considerably on Cliff Lake, reaching a low point in 1994 (Table 16). Since then, rainbow trout catches have been relatively consistent with strong catches in 2000 and 2002. Mean length of rainbow trout caught in gill nets is low, dominated by juvenile fish. The low mean size may be due to strong juvenile populations, but a lack of larger rainbows could also reflect poor growth rates.. The impact of parasite loads has not been adequately analyzed, but is likely the prime factor limiting growth and survival.

Table 16. Summary of catch rates and average length of rainbow trout caught in gill nets in Cliff Lake, 1991 – 2002.

YEAR	Number	Number per net	Mean length
1991	46	7.7	12.4
1993	21	4.2	15.5
1994	9	1.8	12.3
1998	31	6.2	8.9
1999	26	5.2	10.9
2000	49	9.8	9.4
2001	25	6.3	10.2
2002*	59	8.4	10.3

* 7 nets

Hyalite Reservoir

Spawner counts in the West Fork Hyalite Creek indicate Yellowstone cutthroat trout and Arctic grayling may be recovering from the loss of spawning habitat due to raising reservoir levels (Byorth and Weiss 2001). In 2001, a total of 2643 YCT were observed in the West Fork, a record high (Table 17). Spawner counts were lower in 2002, but numbers of mature spawning YCT appear to be strong. Since 1998, the numbers of adult Arctic grayling observed has stabilized near 20 per survey (Table 18). In 2002, the observed number of spawning Arctic grayling decreased but is stable.

A fall gill netting series was conducted on Hyalite Reservoir, the first since 1998. In 2002, a total of 80 YCT, 5 brook trout, and 1 grayling were captured in 4 nets. In contrast, 60 YCT, and 10 brook trout were captured in 1998. Mean length of YCT increased from 11.4 inches in 1998 to 13.0 inches in 2002. Netting results appear to corroborate spawner counts in indicating a relatively stable YCT population.

Table 17. Numbers of Yellowstone cutthroat trout (YCT) observed during spawner counts in the West Fork Hyalite Creek, 1995 – 2002, * indicates years of incomplete surveys. Updated from Byorth and Weiss 2002.

Year	Number of Surveys	Number YCT Observed	Number YCT Per Survey	Peak Spawning Date
1995	6	259	43.2*	June 12*
1996	4	13	4.3*	*
1997	8	364	45.5	June 23
1998	16	1891	118	May 28
1999	11	1704	155	June 11
2000	9	1640	182	June 2
2001	8	2643	330.4	June 6
2002	7	1980	282.2	June 7

Table 20. Numbers of Arctic grayling observed during spawner counts in the West Fork Hyalite Creek, 1986, 1989 – 2002, * indicates years of incomplete surveys. Updated from Byorth and Weiss 2002.

Year	Number of Surveys	Number Grayling Observed	Number Grayling Per Survey	Peak Spawning Date
1986	1	152	152	June 16
1989	*	85	*	*
1990	3	180	60	June 26
1991	1	50	50	June 26
1992	2	154	77	June 10
1993	16	555	34	June 21
1994	20	945	47	June 6
1995	7	45	6.4*	June 29*
1996	4	0	0*	*
1997	8	5	0.6	June 23
1998	16	453	28.5	June 22
1999	11	203	18.5	June 24
2000	9	130	14.4	June 13 – 19
2001	8	175	22	June 19
2002	7	108	15.4	July 1

Miscellaneous Surveys

At Moon Lake, we electrofished approximately 100 yards of the inlet stream immediately above the lake. We captured 18 rainbow-cutthroat hybrid trout ranging in length from 3.3 to 14.0 inches, with an average of 11.6 inches. Ten of the 18 were over 12 inches long. Spawning was underway, with 4 spent females of the 9 mature females captured. The remainder was ripe. We also observed a few yearlings, which appeared to be a couple inches long. The Gallatin-Madison mountain lakes database indicated that Yellowstone cutthroat trout were planted in 1995. A previous USFS report lists wild rainbow. Obviously, the population is wild and self-sustaining, with good age distribution. Scales were collected for aging.

Deer Lake historically supported a wild Arctic grayling population. Deleray (1992) estimated the spawning population to be 803 ± 104 in 1989 and 1109 ± 124 in 1990. Scott Barndt, USFS, and Cal Kaya, MSU, conducted a marking run on 6/25/02 using a battery backpack unit. We followed up with a recapture

run on July 2. Both crews electrofished only the staging areas outlined by Deleray (1992) and did not enter the spawning area. Our combined population estimate for mature fish:

$$M = 75 \text{ (over 8.0 inches), } C = 63 \text{ } R = 5$$

$$\text{Therefore, } N^{\wedge} = [(75 + 1)(63+1)/(5+1)] - 1 = 809 \pm 265$$

Size range of mature fish 7/2/02 was 10.7 – 14.7 inches with an average of 13.2 inches. On 6/25 length range was 8.6 - 14.5 inches. Barndt and Kaya captured 51 immature grayling ranging from 2.6 to 8.05 inches. Sex ratio was 28 f:35 m on 7/2/02, and 38f:37m on 6/25/02. We captured spent females and found eggs in the spawning stream indicating that peak spawning was underway. We observed spawning behavior, paired fish, and aggression and observed 6 – 8 inch grayling and 2-3 inch grayling in stream. All size classes were apparent and this population is stable.

Conclusion

In the Madison and Gallatin drainages whirling disease, flow regimes, drought, winter conditions, predation (human and otherwise), and habitat condition each play a role in regulating trout abundance. Most recently, persistent drought has effected populations in most of the area. However, milder winters and low runoff appears somewhat beneficial to trout in the Gallatin Canyon. The interplay of whirling disease and low winter flows appears to be impacting trout in the upper Madison drainage, especially in the Pine Butte Section. While both rainbow and brown trout abundance decreased in the Pine Butte section, trout abundance was stable in the Varney section. In the Norris section, below Ennis Lake, the older age classes of brown trout, and to some extent rainbow trout, appear to be impacted by drought conditions. Trout populations in the East Gallatin River also reflect drought impacts with decreasing abundance especially at older ages. In both Thompson and Hoffman sections, declining recruitment may be due to increasing intensity of whirling disease.

Catch-per-effort trends in Hebgen Lake increased to respectable levels after the temporary low in 2001. In Hyalite Reservoir gill net catches and spawner counts suggest a stable fishery. While gill net catches of rainbow trout on Cliff Lake were respectable, growth still appears to be hampered by parasite loads. Moon Lake supports an apparently stable population of wild rainbow-cutthroat hybrids. The Arctic grayling population in Deer Lake is self-sustaining and is similar in abundance to previous surveys.

This document reports monitoring activities in the Madison and Gallatin drainages during 2002. Summary data are provided to illustrate trends in fish populations or to address specific management concerns. Conclusions beyond the scope of basic trends are speculative and they would require more in-depth analysis.

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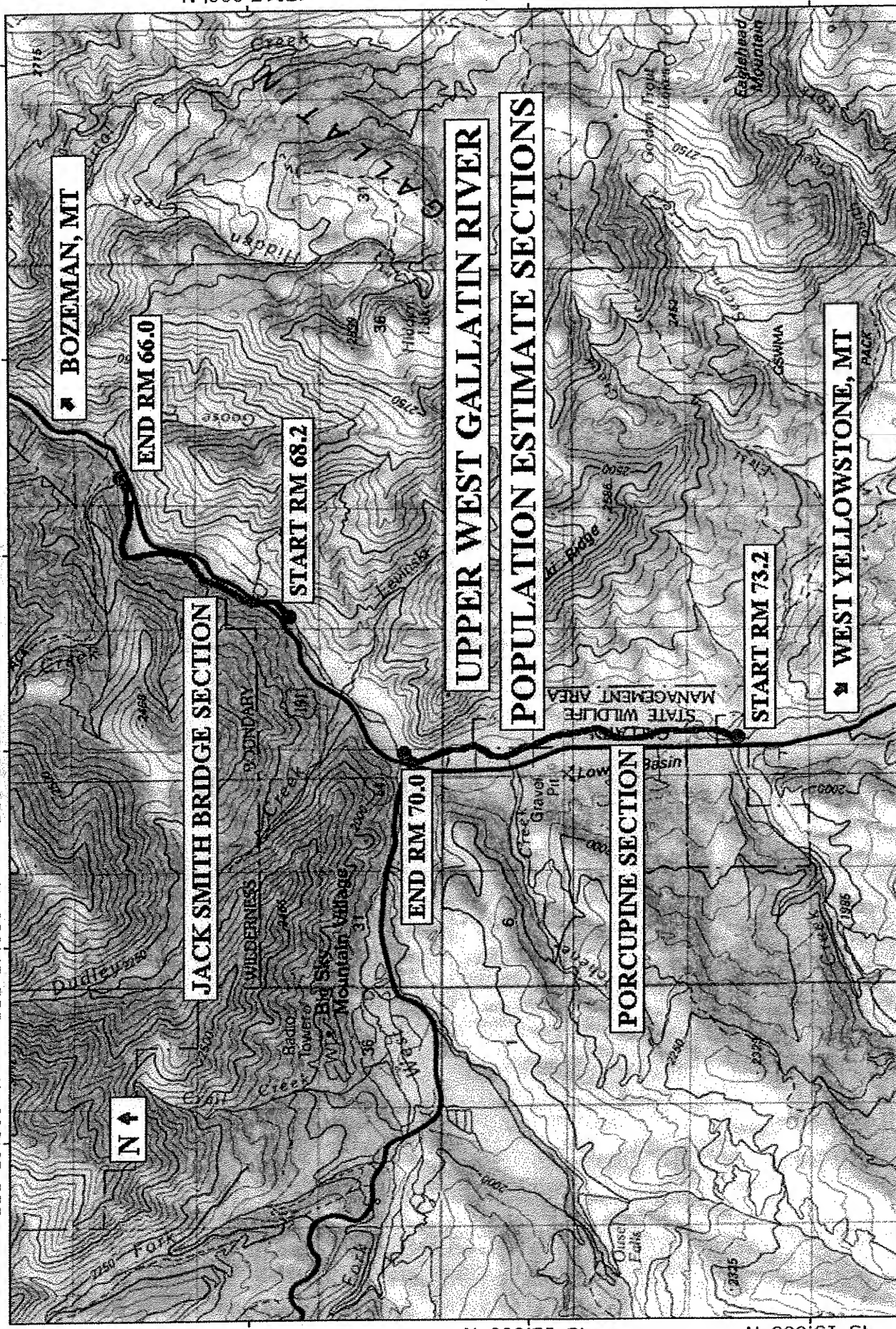
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Appendix A. Maps of streams, lakes, and reservoirs displaying study sections.

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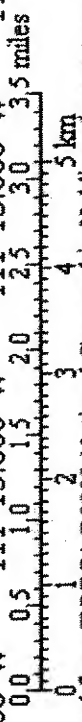
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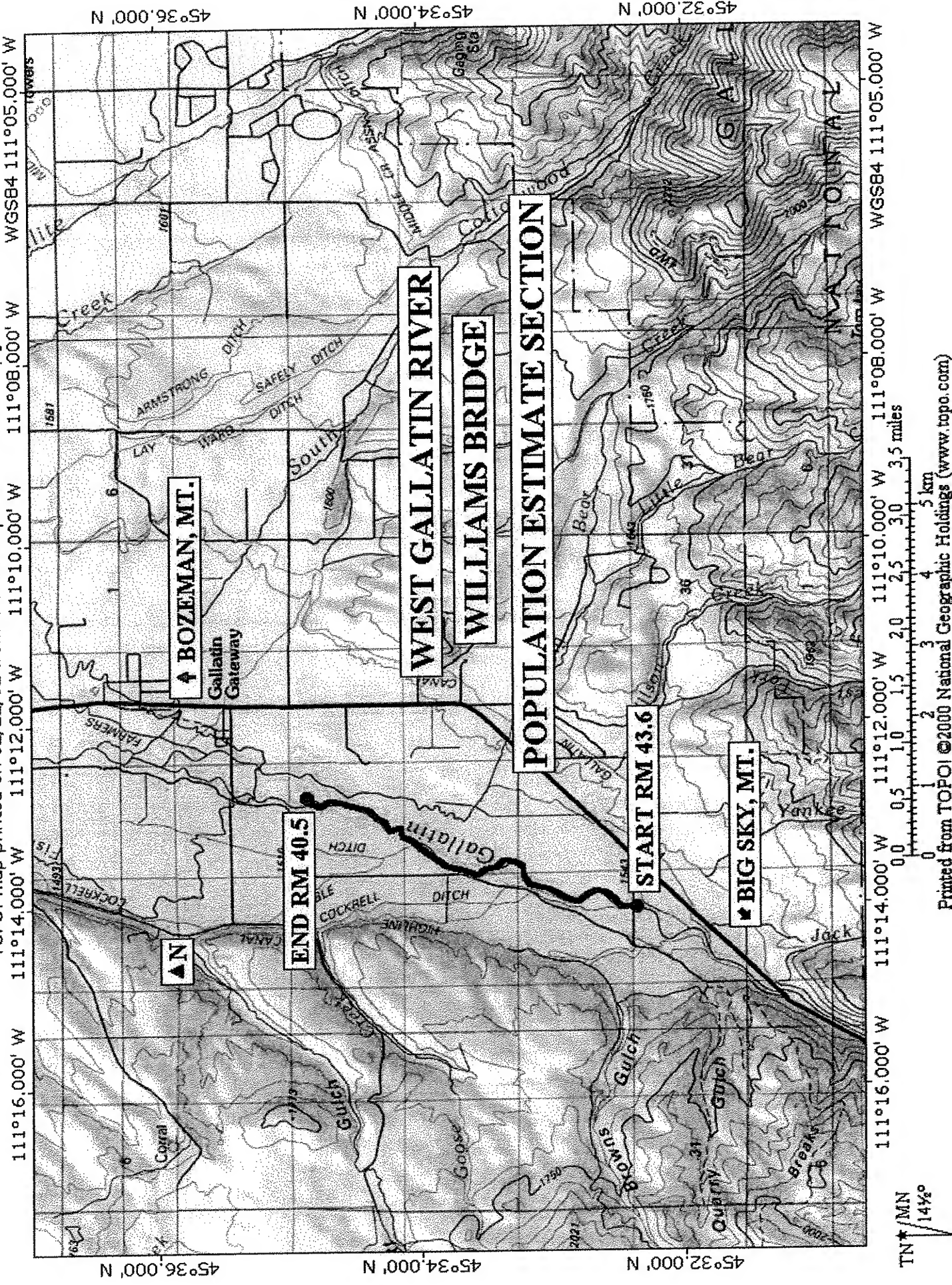
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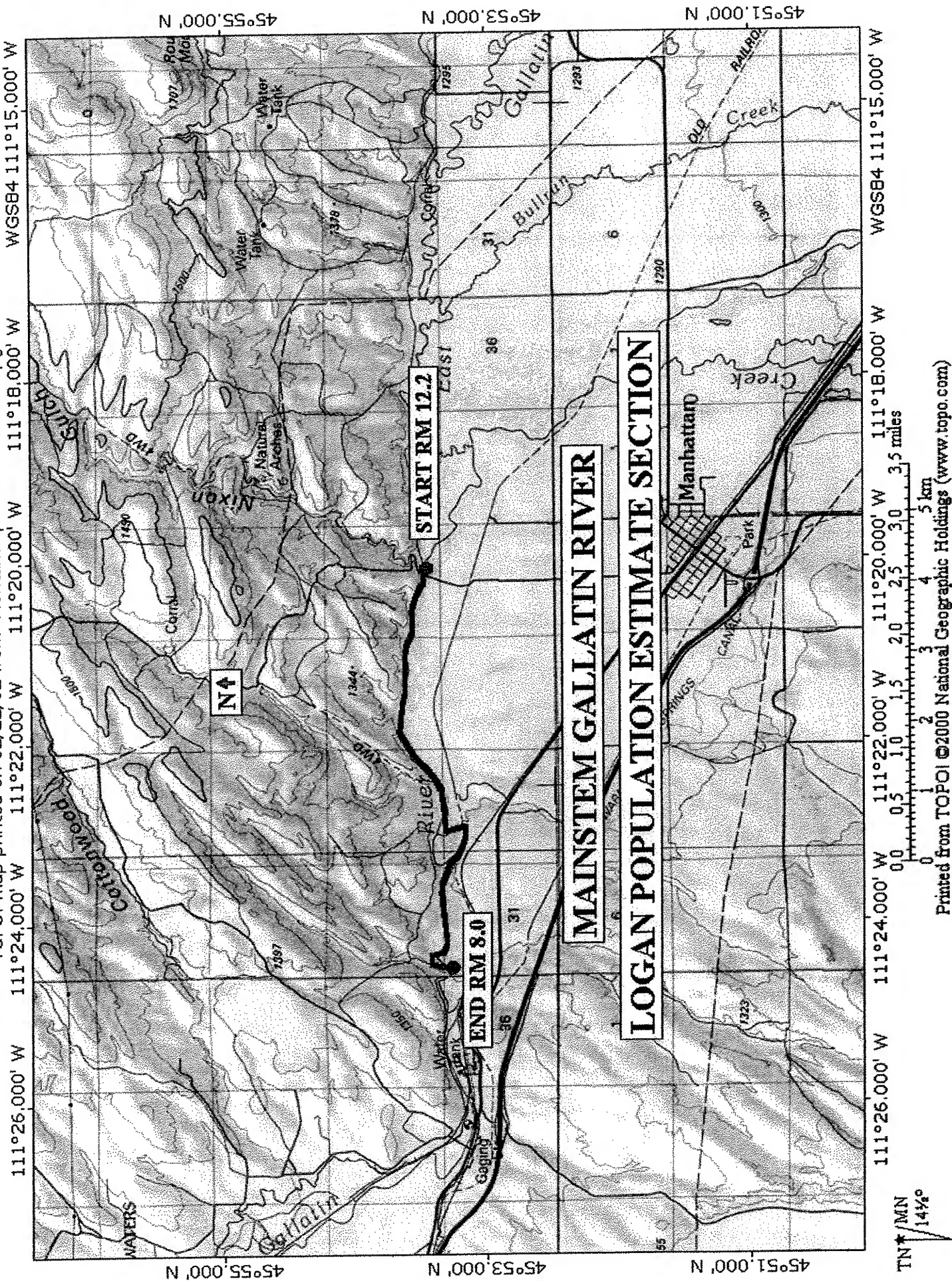


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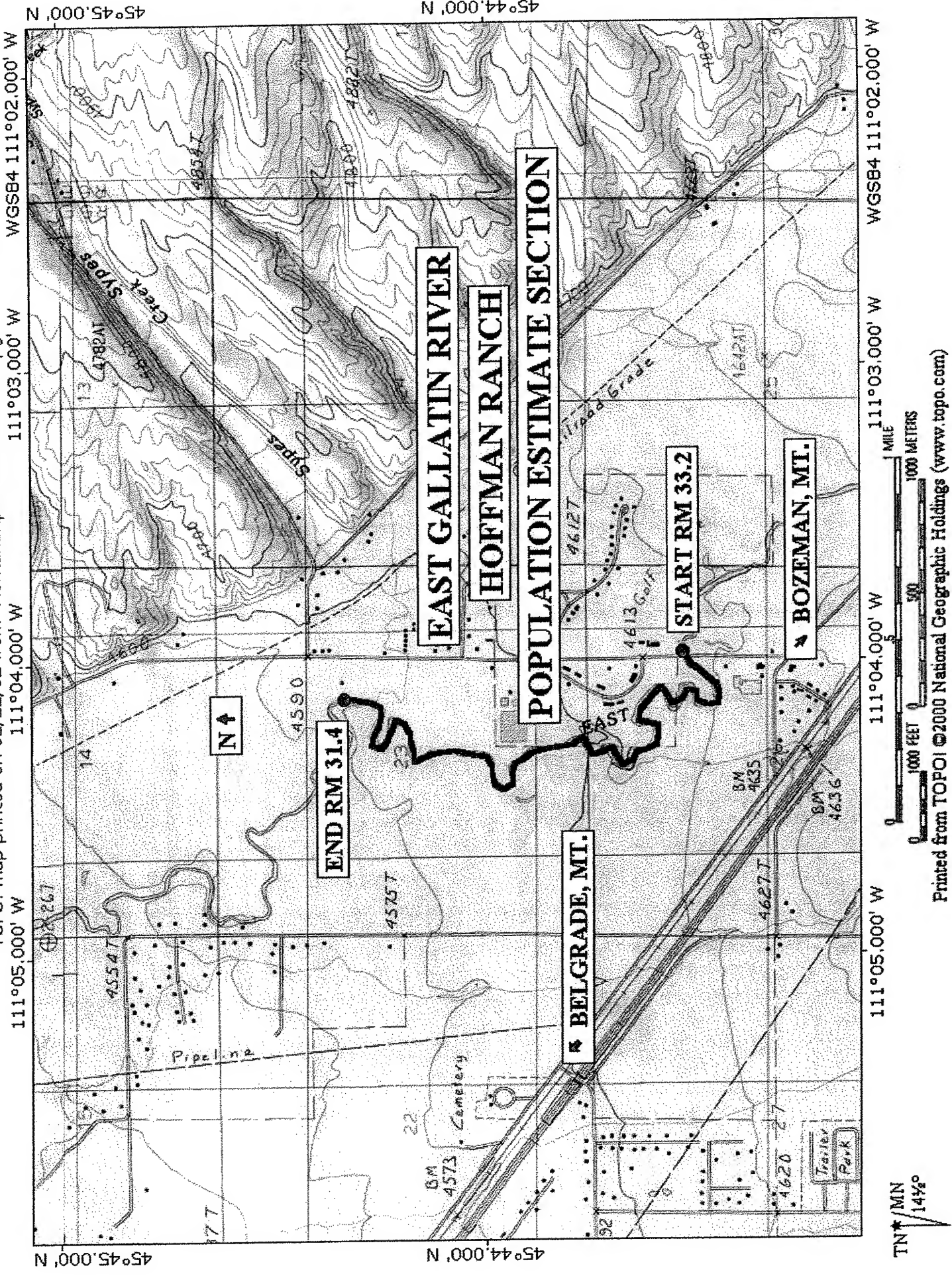
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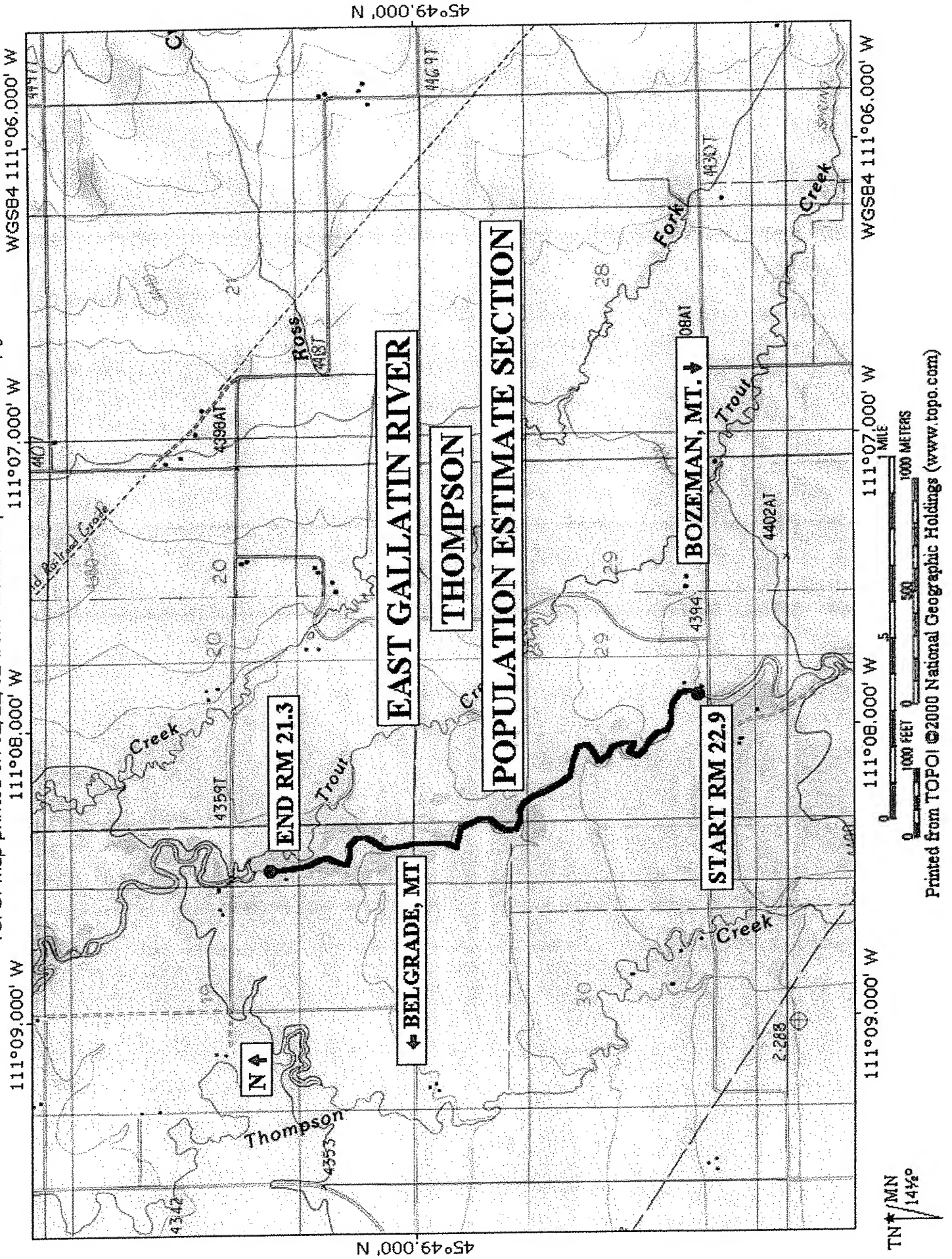


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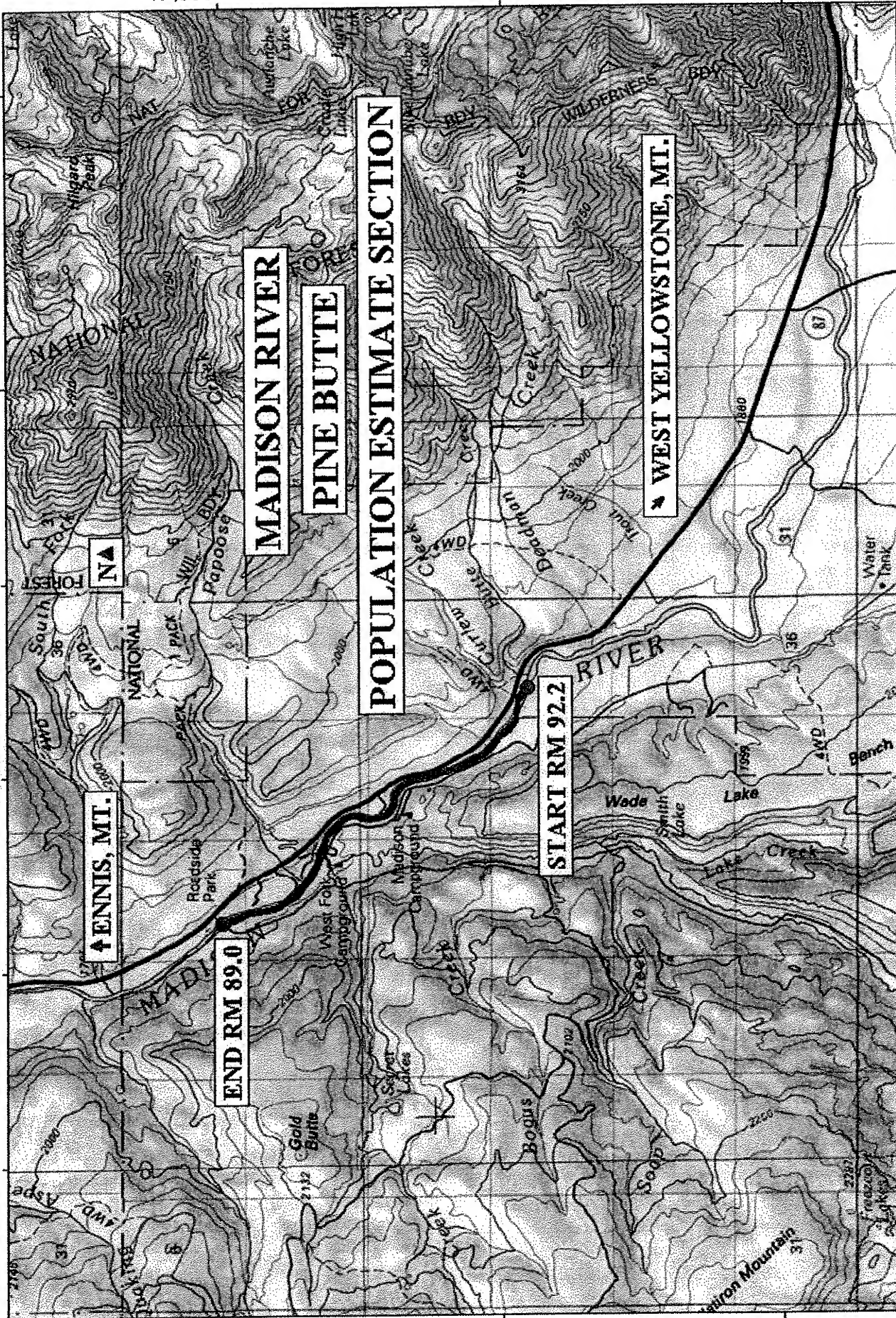
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TN* / MN
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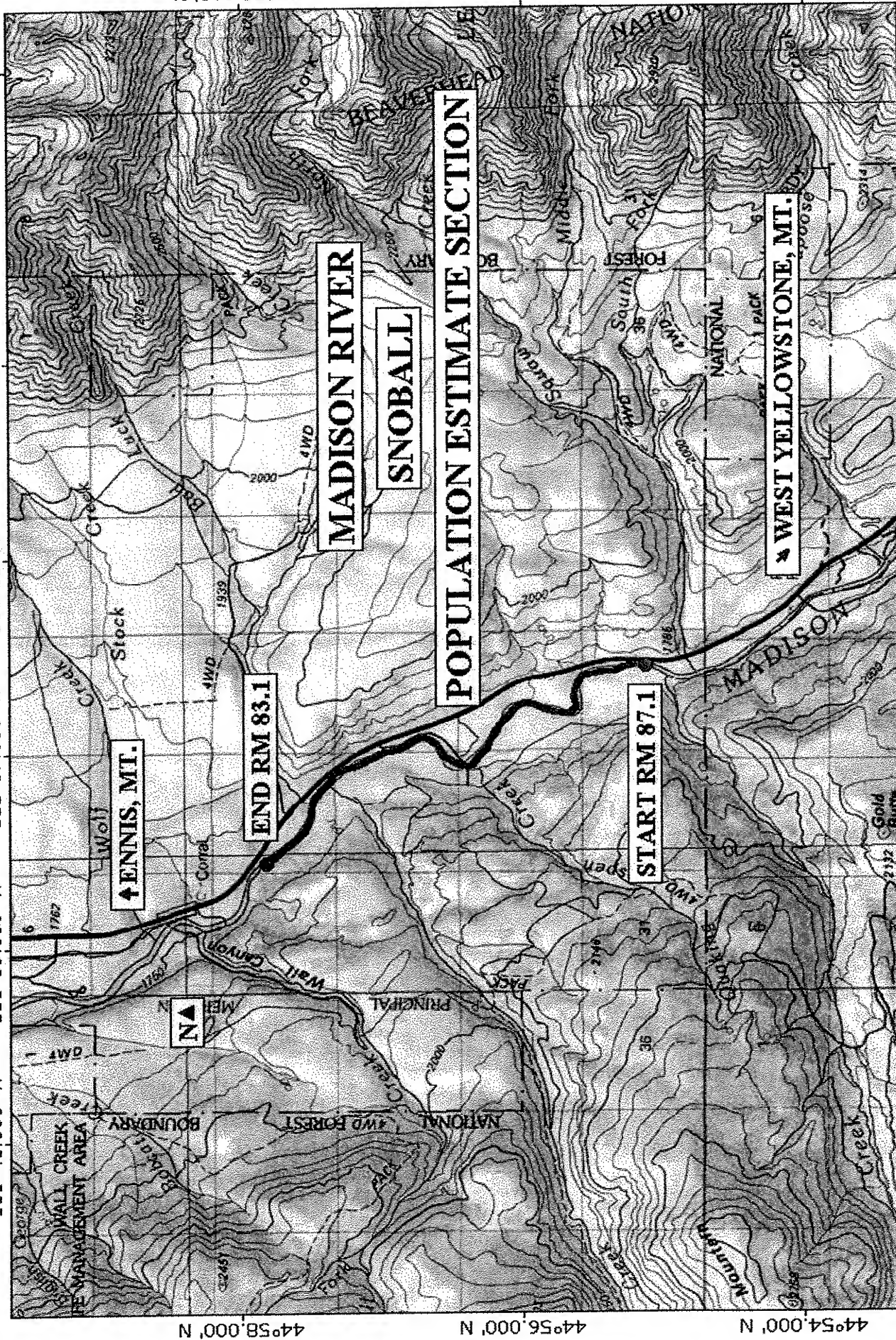
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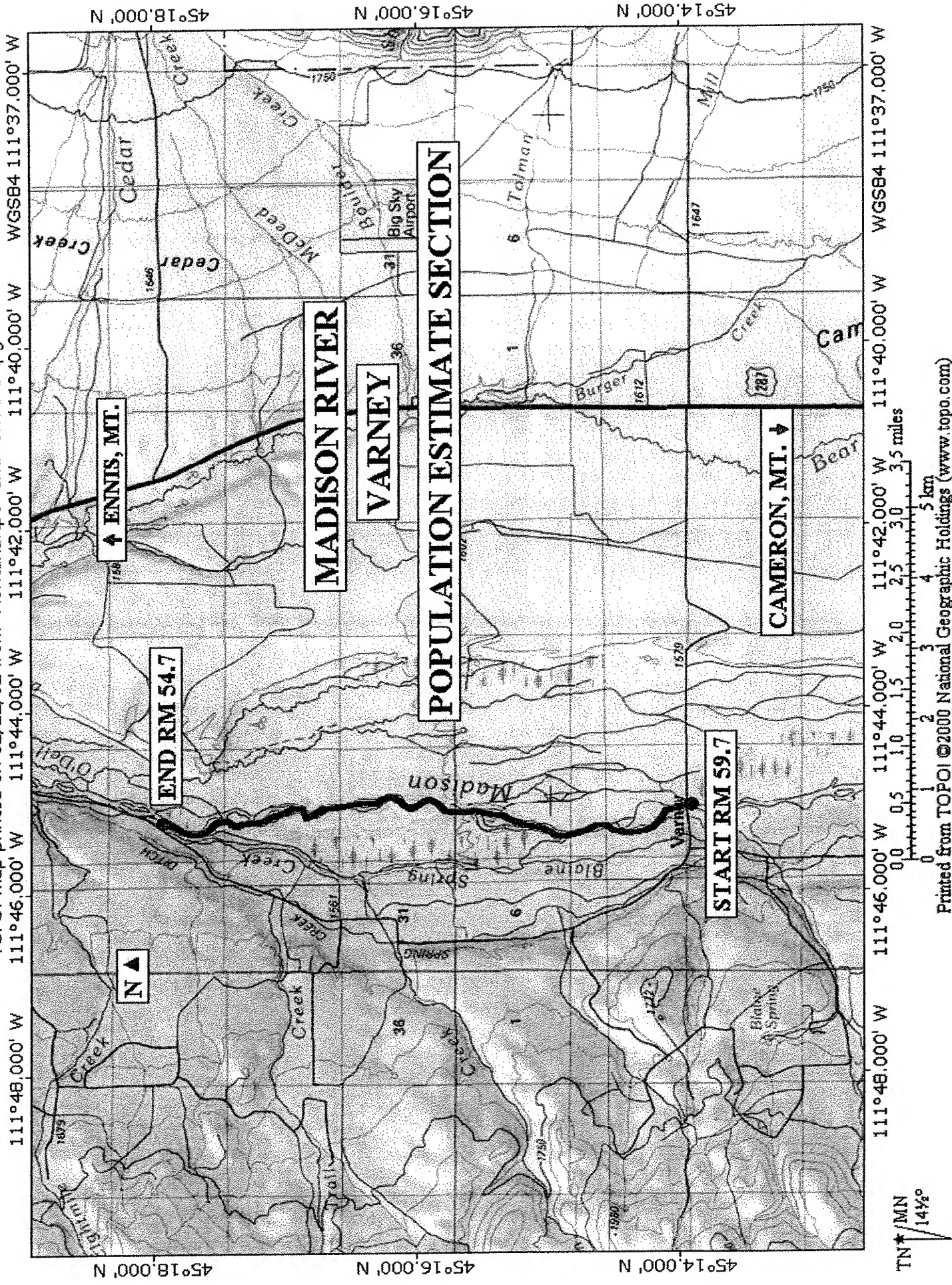
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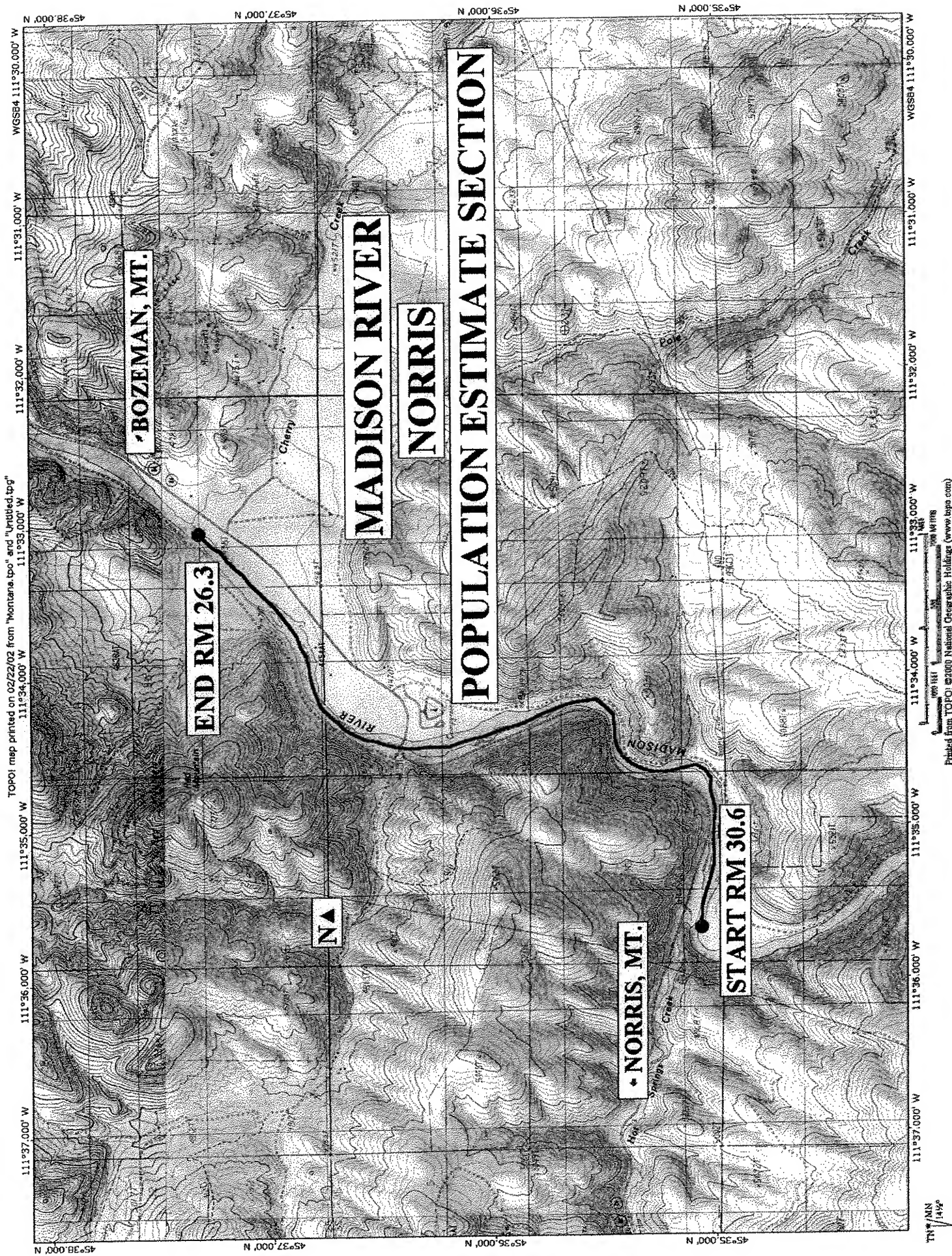


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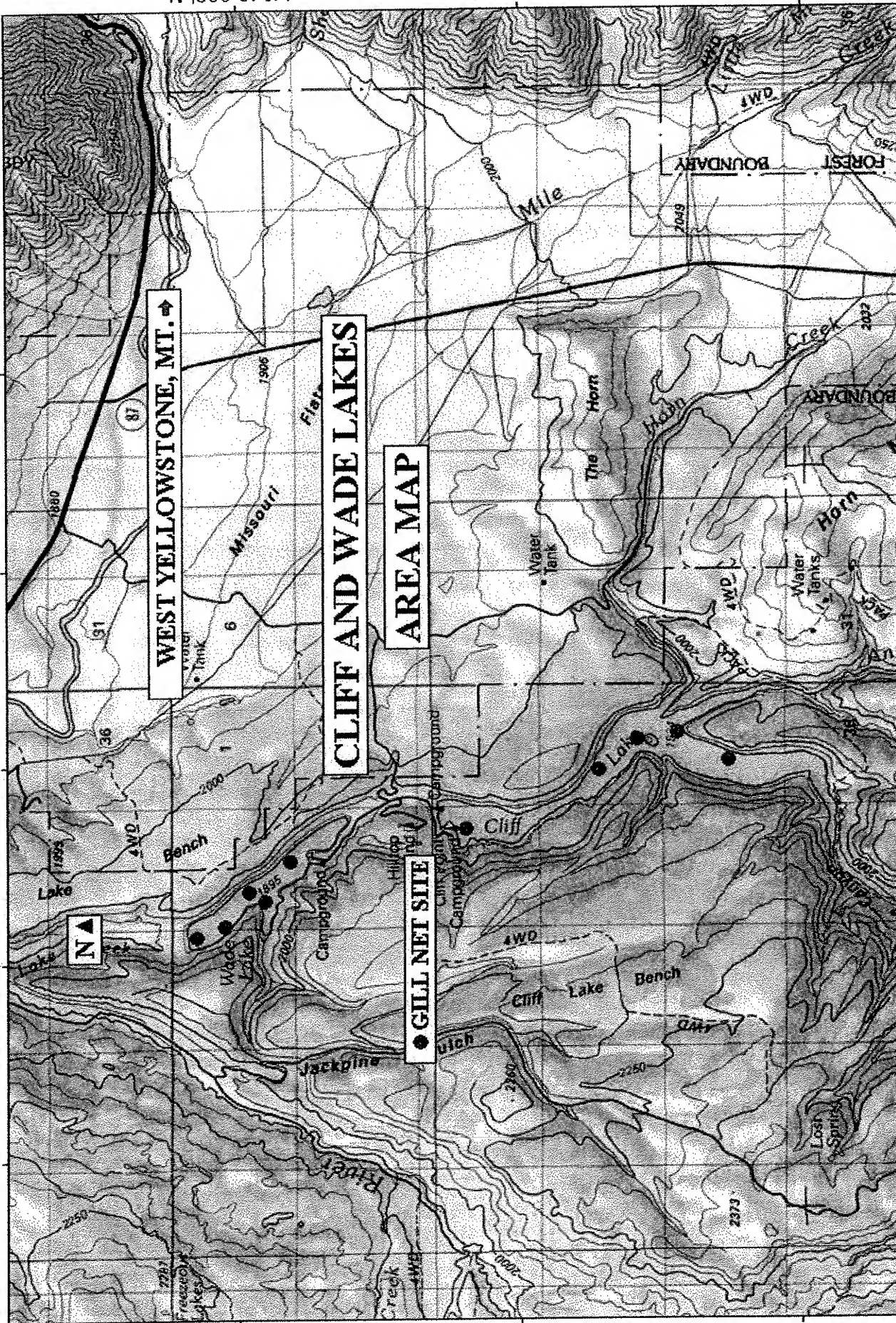


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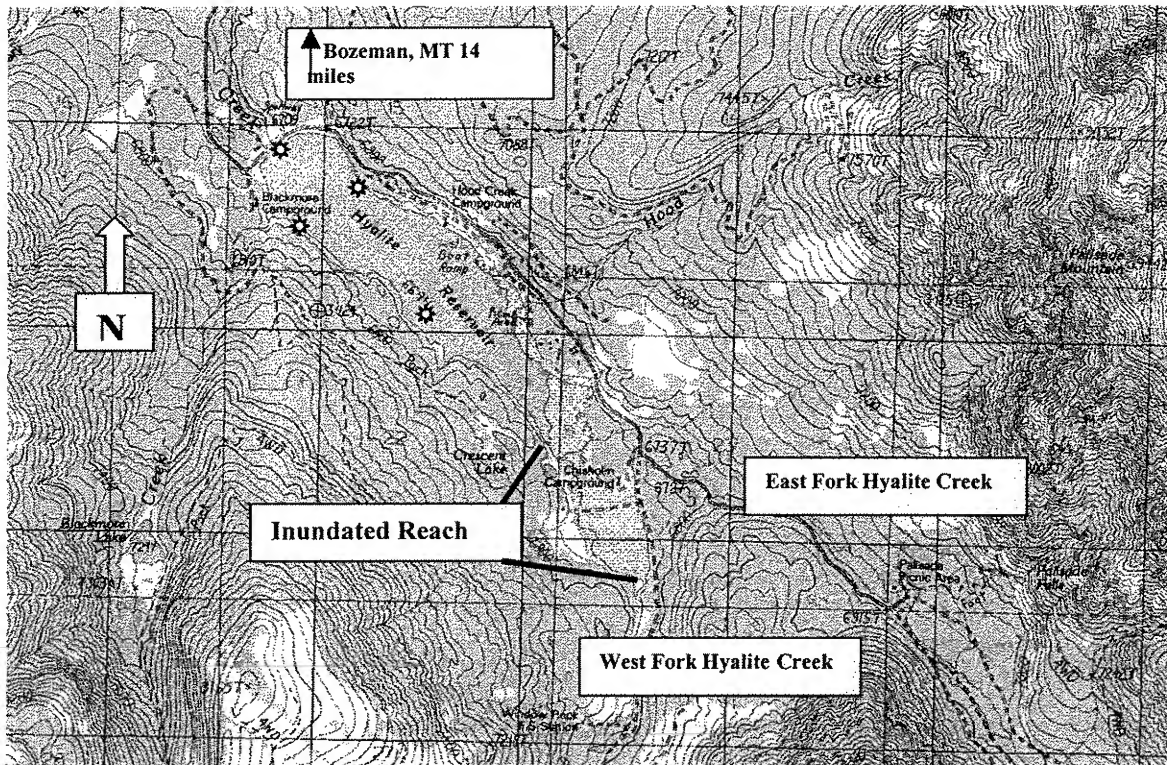
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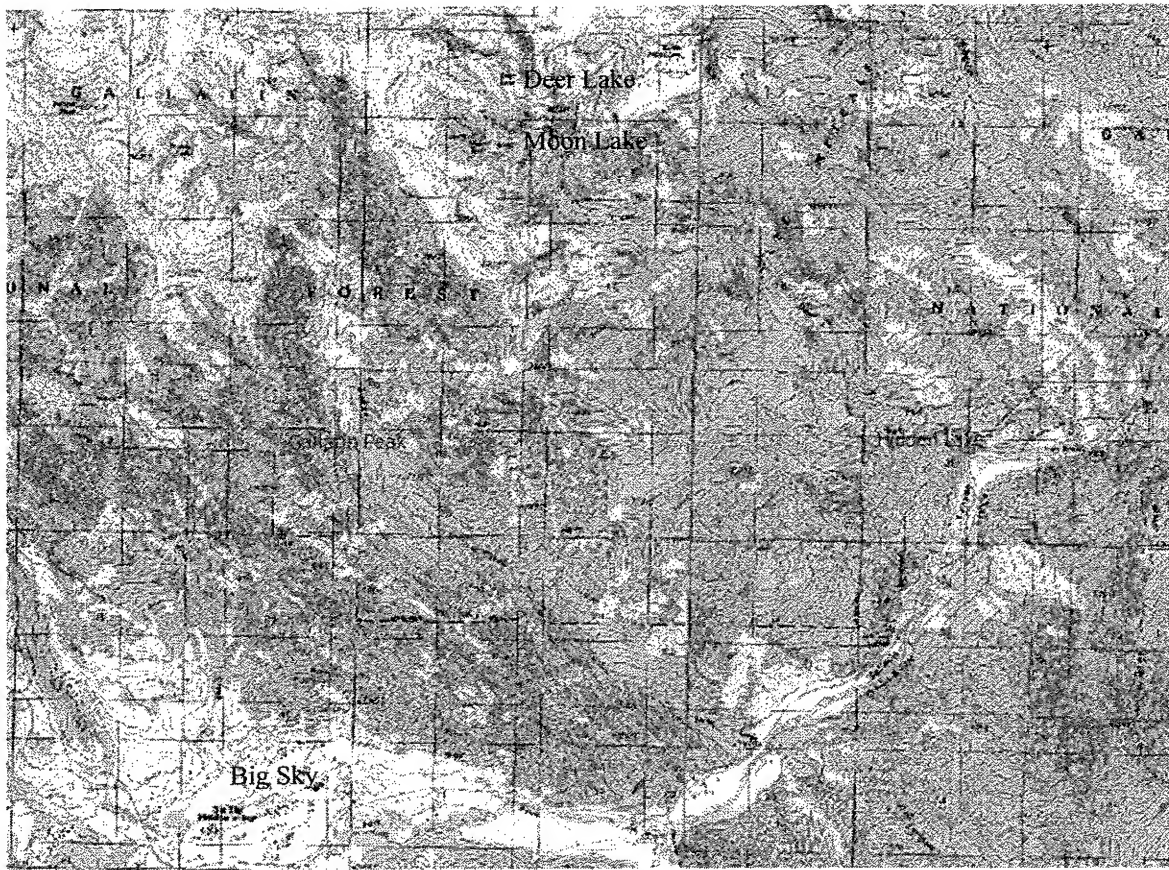
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TN/MN
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0 0.5 1 1.5 2 3 4 5
0 0.5 1 1.5 2 3 4 5
miles km



Map of Hyalite Reservoir. Stars indicate gill net sites and scale is approximately 1 inch = 0.5 miles.



Vicinity Map of Deer and Moon Lakes, Montana

